TECHNICAL MEMORANDUM

Client:	City of The Dalles		
Project:	Focused Assessment of Water Infrastructure		
Project File:	MFA 719.101	Project Manager:	Ryan M. Withers, PE
Composed by:	Ryan M. Withers, PE		
Reviewed by:	Paul R. Cross, PE		
Subject:	310 Zone Buildout Infrastructure Analysis		
Date:	December 10, 2020		

EXPIRES: 06/30/2022
Signed: 12/10/2020

EXPIRES: 12/31/2021
Signed: 12/10/2020

Background

This technical memorandum provides a focused assessment of water infrastructure for redevelopable industrial and commercial parcels located in the City of The Dalles (City). Non-residential development within the City is anticipated to be highly concentrated within the northwest portion of the City, inside the 310 Pressure Zone of the City's water system. Future development within the City is primarily guided by the City's *Comprehensive Land Use Plan*, last issued in May 2011. Since 2011, at least two documents have been prepared to report on development progress and identify potential City development areas:

- *The Dalles Growth Management Report,* Winterbrook Planning, May 2013.
- *The Dalles Buildable Lands Inventory – Methodology and Results*, Angelo Planning Group, December 2016.

The 2013 *The Dalles Growth Management Report* identifies the City's buildable lands inventoried on a parcel-by-parcel basis including categorizing vacant or redevelopable commercial, industrial, employment, residential, and mixed-use land. The subsequent 2016 *The Dalles Buildable Lands Inventory – Methodology and Results* document pinpoints the residential and employment/non-residential growth areas within the City. *The Dalles Buildable*

Lands Inventory – Methodology and Results document identifies the northwest portion of the City as a critical job creation area with a significant potential for redevelopment of large industrial properties, without requiring an expansion of the City's Urban Growth Boundary (UGB).

Both City planning documents point to a strategy of redevelopment of vacant industrial properties that are largely underdeveloped and underserved by City utilities. The largest vacant parcels are located within the "310 Zone" of the City's water system, which refers to the a discrete pressure zone within the larger City water system. Prior to development of the vacant parcels, the water infrastructure serving this area should be analyzed and improvements sized for future development needs should be identified in the City's water system planning documents. The information presented in this document is provided for consideration in the City's upcoming Water System Plan Update.

Purpose

The purpose of this technical memorandum is to analyze the water system infrastructure necessary to support future development and redevelopment of employment/non-residential (employment) growth areas within the City's 310 Zone. A technical memorandum prepared by GSI Water Solutions, Inc. in September 2020, presents a detailed analysis of the City's water supply source capacity and source-related options to support the buildout demand projections of the City's 310 Zone.

310 Zone Summary

The City's 310 Zone is the largest pressure zone in the City's water system in terms of gross area served and also total consumption. The 310 Zone's 2018 average day demand (ADD) was approximately 1.92 million gallons per day (MGD)[1], equivalent to over half of the City's system-wide 2018 ADD of 3.48 MGD.

The 310 Zone has the lowest hydraulic grade of the City's pressure zones, and is the northern and western-most pressure zone in the City's water system. The 310 Zone is not directly connected to any storage or source facilities, with normal supply to the 310 Zone conveyed via multiple pressure reducing valve (PRV) stations from the 395 Zone. Conveyance capacity to the 310 Zone is limited by the PRV stations and associated piping that supply the 310 Zone, and conveyance capacity to a large portion of the 310 Zone north of Interstate 84 (I-84) is limited to three water mains that cross I-84, as shown in **Figure 1**.

[1] Calculated based on hydraulic model demands provided by the City.

Legend

Existing Water Infrastructure

- Reservoir
- Booster Pump Station
- Well
- PRV

Water Main Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660
- 660E
- 786
- 880

The Dalles Dam

Columbia River

Intermediate Reservoir

Columbia View Reservoir

Garrison Reservoir

Vista Reservoir

From Wicks WTP

PRELIMINARY

This map is a graphic representation derived from the City of The Dalles Geographic Information System. It was designed and intended for City staff use only; it is not guaranteed to survey accuracy. This map is based on the best information available on the date shown on this map.

Vicinity Map

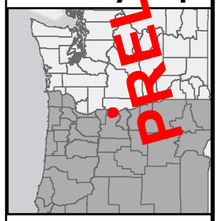


Figure 1
Existing Water System

1 inch = 2,000 feet

0 500 1,000 2,000 Feet

DRAWING IS FULL SCALE WHEN BAR MEASURES 1"

RH2

NORTH

C:\USERS\APELLETIER\DESKTOP\FIGURE 1.MXD BY: APELLETIER PLOT DATE: APR 23, 2020 COORDINATE SYSTEM: NAD 1983 STATEPLANE OREGON NORTH FIPS 3601 FEET

Demand Analysis

Existing Demand

The City's existing system-wide demand was calculated using City-provided supervisory control and data acquisition (SCADA) for 2018 and a portion of 2019.

The maximum demand consumed in the system in a single day was calculated to be 9.0 million gallons per day (MGD) or 6,250 gallons per minute (gpm), as measured by the City source meters and reservoir level transducers on August 6, 2019.

Future Demands

Future growth and demands for employment land uses within the City's system are anticipated to predominantly occur within the City's 310 Zone, as shown in Map 1 – Buildable Lands Inventory of the City's 2013 *Growth Management Report* (**Attachment A**).

Future 310 Zone demands in addition to the zone's existing demands were estimated based on the vacant or redevelopable commercial and industrial area in the 310 Zone per the figure included in **Attachment A**. The future 310 Zone demands are also based on a unit demand per acre of commercial and industrial land uses based on unit demands of other Pacific Northwest water systems with significant and similar commercial and industrial areas, as shown in **Table 1**.

Attachment A indicates approximately 50 acres of currently vacant or redevelopable commercial land, and approximately 348 acres of currently vacant or redevelopable industrial land. Based on unit average day demands (ADD) per acre of each land use in other Pacific Northwest water systems, the estimated additional buildout maximum day demand (MDD) of the 310 Zone is calculated to be approximately 6.8 MGD (4,740 gpm). This demand is in addition to the 310 Zone's existing ADD and MDD, based on the City's historical system-wide MDD/ADD peaking factor of 2.58. The use of the City's historical peaking factor may be conservative as peaking factors generally decrease and demands increase. The additional ADD and MDD buildout demand estimates are shown in **Table 1**.

Table 1: 310 Zone Additional Buildout Demand Estimates

Description	Area (acres)	Unit ADD (MGD/acre)	ADD (MGD)	MDD (MGD)
Vacant Commercial	16.4	0.0013	0.02	0.05
Redevelopable Commercial	33.9		0.04	0.11
Vacant Industrial/Employment	52.9	0.0074	0.39	1.01
Redevelopable Industrial/Employment	295.6		2.19	5.64
Total (acres)	**398.8**	---	---	---
Total (MGD)	---	---	**2.64**	**6.82**
Total (gpm)	---	---	**1,840**	**4,740**

Commercial = Average of Kent and Marysville's commercial demand per acre, based on information presented in each City's Water System Plan.

Industrial = Median demand per acre of industrial customers in Whatcom PUD's water system, based on information presented in the PUD's Industrial Water Supply System Capital Improvement Plan.

The demand estimates presented in **Table 1** represent the additional demand that may occur in the 310 Zone, beyond the zone's existing demands. **Table 2** presents the 310 Zone's estimated existing and buildout ADD and MDD projections. The difference between the projected buildout MDD of 11.78 MGD (8,180 gpm) and the existing MDD of 4.95 MGD (3,440 gpm) shown in **Table 2** is equivalent to the 6.82 MGD (4,740 gpm) of additional 310 Zone demand shown in **Table 1**.

Table 2: 310 Zone Total Demands

Description	ADD (MGD)	MDD (MGD)
Existing	1.92	4.95
Buildout	4.57	11.78

Description	ADD (gpm)	MDD (gpm)
Existing	1,330	3,440
Buildout	3,170	8,180

Note: components may not sum between tables due to rounding.

310 Zone Analysis

Existing Level of Service

The existing level of service provided in the 310 Zone varies between the zone's two primary areas: (1) the City's downtown area, and (2) the City's industrial area. With the overwhelming majority of the 310 Zone's vacant and redevelopable land within the City's industrial area north

of I-84, this area will be the focus of the level of service analysis presented in this memorandum.

An existing water main loop is installed throughout the industrial area, with an 18-inch-diameter main installed within W 2nd Street and a 12-inch-diameter main installed within River Road. The existing pressures during existing MDD conditions range between 65 and 73 psi[2] along this water main loop. The existing fire flow availability along this water main loop is at least 3,800 gpm, based on maintaining a residual pressure of 20 psi to all 310 Zone service connections and without consideration for a maximum velocity constraint. For reference, the existing system MDD is 6,250 gpm (9.0 MGD), with the existing 310 Zone MDD estimated to be 3,438 gpm (4.95 MGD).

Existing Limitations

Supply limitations to the 310 Zone begin at the most upstream portion of the City's water system, beginning with limitations at the City's water treatment plant and it's conveyance system, as supply from the City's surface water sources ultimately are conveyed to the 310 Zone via multiple PRV stations. Supply limitations to the 310 Zone are exacerbated within the City's transmission system as a result of a series of PRV stations, with water from the 460 Zone conveyed to the 395 Zone via PRV stations, and water subsequently conveyed from the 395 Zone to the 310 Zone via PRV stations. The series of PRV stations upstream of the 310 Zone provide hydraulic limitations to the supply available to the 310 Zone. Specifically, a short (approximate 30-foot section) of existing 6-inch-diameter main in Mt. Hood Street between W 17th Street and W 18th Street limits the pressures available in the 460 Zone during high-demand conditions, and restricts the conveyance through the 460 Zone.

Subsequently, once the water is within the 310 Zone, supply to the industrial area in the 310 Zone north of I-84 is further limited by three transmission mains that cross I-84 (one 8-inch-diameter main and two 12-inch-diameter mains). These three transmission mains have a combined conveyance capacity of approximately 6.7 MGD (4,650 gpm) while flowing at a velocity of 5 feet per second, which is widely recognized as the industry-standard maximum design velocity for transmission main conveyance. Additional conveyance capacity to the 310 Zone, and additional source and/or storage facilities within the 310 Zone would be required to accommodate growth and future demands within the 310 Zone.

Buildout Level of Service

Existing System Infrastructure

The existing system does not have sufficient conveyance capacity to convey an additional 6.82 MGD (4,740 gpm) (per **Table 1**) to the 310 Zone industrial area. Without improvements to the existing system, pressures in the W 2nd Street and River Road loop will decrease below 20 psi with the addition of approximately 6.82 MGD (4,740 gpm) of demand on a MDD basis.

[2] Pressures calculated with the City's hydraulic model, which was calibrated based on field pressure and flow measurements in Fall 2019.

Legend

Existing Water Infrastructure

- Reservoir
- Booster Pump Station
- Well
- PRV

Buildout Infrastructure Needs

- Tank
- Booster Pump Station
- Well
- PRV

Water Main Segment

- A
- B
- C

Water Main Pressure Zone

- 310
- 352
- 395
- 395W
- 460
- 475
- 507
- 513
- 560
- 632
- 660
- 660E
- 786
- 880

Buildout Water Infrastructure Needs

11 MG Storage
6.8 MGD Source Capacity
9,000 gpm (13 MGD) Firm Capacity BPS

24"
24"
24"

The Dalles Dam
Columbia River
Intermediate Reservoir
Columbia View Reservoir
Vista Reservoir
Garrison Reservoir
From Wicks WTP

PRELIMINARY

Vicinity Map

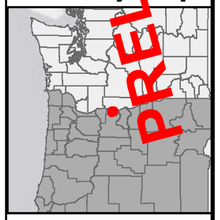


Figure 2
Buildout Infrastructure Needs

1 inch = 2,000 feet

0 550 1,100 2,200 Feet

DRAWING IS FULL SCALE
WHEN BAR MEASURES 1"

RH2

NORTH

C:\USERS\APELLETIER\DESKTOP\FIGURE 2.MXD BY: APELLETIER PLOT DATE: APR 23, 2020 COORDINATE SYSTEM: NAD 1983 STATEPLANE OREGON NORTH FIPS 3601 FEET

Future System Infrastructure

Source Capacity Improvement Options

The 310 Zone is currently a closed pressure zone, which does not have any direct supply or storage facilities within the zone. To accommodate an additional 6.82 MGD (4,740 gpm) of demand on a MDD basis, additional source capacity is required in the water system. If groundwater wells are constructed within the 310 Zone industrial area, the supply from these sources does not have to be conveyed across I-84 and would bypass a conveyance constriction in the 310 Zone. In total, at least 4.7 MGD (3,264 gpm) of additional source capacity is needed within the 310 Zone industrial area to meet demand projections, as shown in **Table 3.** This table presents the source capacity of the entire system at full buildout with the existing system's sources. The development of additional source capacity to meet increased demand should provide adequate supply based on wells operating 20 hours per day or less. With 6.82 MGD (4,740 gpm) of additional source capacity within the 310 Zone, the City would have the ability to meet the system's projected buildout demand with one well out of service. This is shown schematically in **Figure 2**.

Water quality concerns for groundwater in the 310 Zone provides a challenge for direct use in existing employment areas due to the increased mineral content of the groundwater compared to the City's surface water quality. The increased mineral content of the groundwater poses operational complications for some of the existing and future 310 Zone commercial and industrial users. One option to at least partially mitigate quality concerns would be to construct above ground storage tanks near groundwater extraction wells and provide the piping and manifolds needed to allow for blending of groundwater with treated surface water produced from the City's existing, high quality source. Groundwater wells installed as part of this option are recommended to have permanent backup power automatically available to operate the wells in the event of a power failure. A storage facility with usable storage at an elevation suitable to provide gravity storage to the 310 Zone and/or pumping facility will be necessary to convey water to the existing City distribution system.

Table 3: System-wide Supply Capacity Analysis

Description	2019	Full Buildout
Required Supply (gpm)		
Maximum Day Demand	**6,250**	**10,972**
Available Source Capacity (gpm)		
Wicks WTP (5.0 MGD)	3,333	3,333
Jordan Well	1,750	1,750
Marks Well	1,500	1,500
Lone Pine Well	2,000	2,000
Total Existing Source Capacity	**8,583**	**8,583**
Surplus or Deficient Source Capacity (gpm)		
Surplus or Deficiency (24 hours of pumping)	**2,333**	**(2,389)**
Surplus or Deficiency (20 hours of pumping)	**1,458**	**(3,264)**

NOTES:
1. Industry standard for reliability purposes is to meet MDD while pumping 20 hours per day.
2. The Wicks WTP capacity during low snowpack and dry summers can be reduced to approximately 3.5 MGD. For the purposes of these analyses, a 5.0 MGD flow-through rate was utilized to reflect the Wicks WTP capacity during typical summer weather and snowpack conditions. The resulting treated water flow rate of 4.8 MGD is shown in these analyses.
3. Additional source capacity at the City's Wicks WTP is identified in the City's WSP, but has not yet been constructed.

This technical memorandum assumes the additional source capacity will be constructed within the 310 Zone due to scarce external property and the costs of constructing water main between the 310 Zone and other possible source locations; therefore, it may be advantageous for the City to pursue easements, partnerships with local landowners, or property acquisition for water infrastructure to reach the full development potential of the 310 Zone. An accompanying technical memorandum prepared by GSI Water Solutions, Inc., presents a detailed analysis of the City's water supply source capacity and source-related options to support the buildout demand projections of the City's 310 Zone.

Storage Capacity Improvement Options

The additional demands projected within the 310 Zone result in an increased system-wide storage capacity requirement. Similar to the additional source capacity needs, additional storage capacity is needed to support development in the 310 Zone. To accommodate the future storage requirements of the entire system, approximately 11.5 MG of additional usable storage is required to be available to the 310 Zone, utilizing the same storage component calculations for operational, equalizing, emergency, and fire flow storage as shown in the City

2006 Water System Plan, as shown in **Table 4**, and based on the existing system storage volume. This technical memorandum assumes the additional storage capacity will be constructed within the 310 Zone, and will be entirely usable and available to the 310 Zone.

Table 4: System-wide Storage Capacity Analysis

Description	Existing	Full Buildout
Available/Usable Storage (MG)		
Maximum Storage Capacity	15.93	15.93
Dead (Non-usable) Storage	1.19	1.19
Total Existing Available Storage	**14.74**	**14.74**
Required Storage (MG)		
Operational Storage	3.59	6.30
Equalizing Storage	1.80	3.16
Emergency Storage	9.00	15.80
Fire Flow Storage	0.96	0.96
Total Required Storage	**15.35**	**26.22**
Surplus or Deficient Storage (MG)		
Surplus or Deficient Amount	**(0.61)**	**(11.48)**

Typically ground level storage is constructed at an elevation that can provide gravity service to water system customers. Surrounding ground elevations were reviewed as part of this evaluation, and a ground level tank appears constructible at a number of locations approximately one mile west of the existing W 2nd Street looped water main. Constructing storage at any of the speculative locations will require at least one additional I-84 transmission main crossing and significant easement and property access negotiations.

As an alternative to gravity-served 310 Zone storage, ground level storage could be considered within the 310 Zone, with a booster pump station (BPS) constructed to pump out of a future storage facility, as presented in **Figure 2**. As part of this alternative, it is assumed that any potential 310 Zone wells would directly connect to a future storage facility(ies) to promote blending of the City's existing water supply sources with the future 310 Zone wells reduce the mineral content of the water supplied to the commercial and industrial users and to provide for a required residence time in the event that disinfection is necessary.

A technically similar but less conventional strategy described by GSI indicates that the location of storage in the 310 Zone could incorporate Aquifer Storage and Recovery (ASR) extraction wells, coupled with a BPS facility(ies) to utilize stored ASR water in a way that may reduce the required storage volume available to the system via gravity conveyance.

Based on either of these two 310 Zone storage configurations, a BPS would be required to be able to pump to meet the peak 310 Zone domestic and emergency (i.e., fire flow) demands. The resulting BPS would require approximately 13.0 MGD (9,000 gpm) of firm capacity to meet

buildout demands, which includes one large pump out of service[3]. Due to the large demand needs and corresponding capacity of a proposed BPS, discharge mains should be connected to at least two large diameter water mains. Emergency generators should be considered and installed to ensure a BPS can operate in the event of a power failure.

Transmission Capacity Improvement Considerations

460 Zone

To improve transmission capacity to the 310 Zone, the short (approximate 30-foot section) of existing 6-inch-diameter main in Mt. Hood Street between W 17th Street and W 18th Street can be replaced with 14-inch-diameter water main to match the upstream and downstream piping capacity in Mt. Hood Street.

310 Zone Conveyance

In order for the existing level of service to be maintained at buildout of the 310 Zone, transmission improvements are warranted to increase conveyance to the 310 Zone. This can be accomplished with the installation of approximately 9,200 LF of 24-inch-diameter water main between the Garrison Reservoir and the intersection of Webber Street and W 2nd Street. This water main provides dedicated 460 Zone conveyance from the Garrison Reservoir directly to the existing 12- and 18-inch-diameter water main loop around the City's 310 Zone industrial area. A pressure reducing valve (PRV) station with a 12-inch-diameter PRV would be able to reduce the pressure from the 460 Zone to the 310 Zone, before connecting to the existing 12- and 18-inch-diameter 310 Zone water main in the vicinity of Webber Street and W 2nd Street. This PRV station and 24-inch-diameter water main improvement are shown in **Figure 2**, with the water main identified as Segment A.

310 Zone Looping

Additional 310 Zone loops between W 2nd Street and River Road could provide additional conveyance capacity and redundancy for the industrial area. Completion of these proposed loops will assist in preventing a significant impact to conveyance capacity within the industrial area in the event of a water main break and will provide opportunities for isolation of water main segments for maintenance. These looped segments are shown schematically in **Figure 2**, as Segments B and C, as 24-inch-diameter water mains.

Planning-Level Cost Estimates

Planning-level cost estimates were prepared to identify the order-of-magnitude project costs associated with the suggested water system improvements that would accommodate full utilization of buildable land in the City's 310 Zone. These costs may be allocated and phased to generally align with the pace of development interest in the City. The estimated costs are shown in **Table 4**.

[3] Consistent with the City's design criteria presented in Exhibit 9-1 of the 2006 Water System Plan.

Table 4: Planning-Level Order-of-Magnitude Cost Estimates

Project Name	Construction Cost Subtotal	Indirect Costs	Contingency	Total Project Cost
Transmission Main Projects				
460 Zone Water Main Replacement	$18,000	$7,000	$4,000	$29,000
310 Zone Conveyance (Segment A)	$2,222,000	$778,000	$750,000	$3,750,000
Webber Street 460 to 310 Zone PRV	$98,000	$35,000	$20,000	$153,000
310 Zone Looping (Segments B and C)	$1,265,000	$443,000	$427,000	$2,135,000
Facility Projects				
310 Zone Storage Facilities (11 MG)	$20,300,000	$4,060,000	$3,654,000	$28,014,000
310 Zone Source Facilities (6.8 MGD)	$7,389,000	$1,478,000	$1,331,000	$10,198,000
310 Zone BPS (13 MGD)	$5,710,000	$1,999,000	$1,157,000	$8,866,000
Combined Total	---	---	---	**$53,145,000**

Indirect costs were estimated to range between 20 and 35 percent of the construction cost for engineering preliminary design, final design, and construction management services, permitting, legal, and administrative services.

Project contingencies were estimated to range between 15 and 25 percent of the combined construction cost estimate and indirect cost estimate.

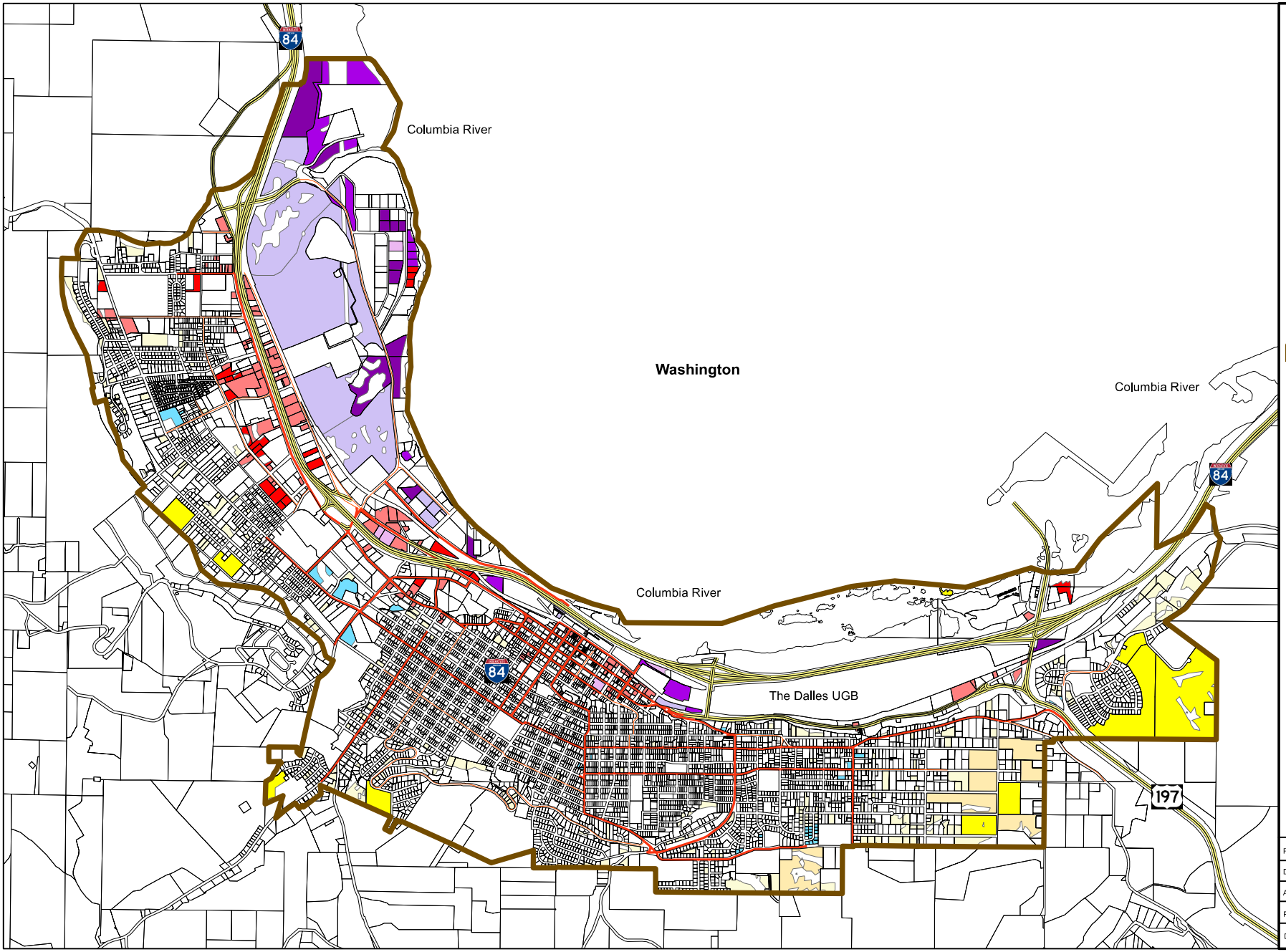
A detailed breakdown of the estimates for each project are shown in **Attachment B**.

Attachments:

A. Map 1 – Buildable Lands Inventory of the City's 2013 *Growth Management Report*
B. Planning-Level Cost Estimates

Attachment A

Map 1 – Buildable Lands Inventory of the City's 2013 *Growth Management Report*



MAP 1

CITY OF THE DALLES

2007 Buildable Lands Inventory within 1983 UGB

Legend

- Existing UGB
- Parcels
- Vacant Commercial
- Redevelopable Commercial
- Vacant Industrial
- Redevelopable Industrial
- Vacant Employment
- Redevelopable Employment
- Mixed Use
- Vacant Residential
- Partial Vacant Residential
- Infill Residential

Road Classification

- Arterial
- Collector
- Highway

0 0.1250.25 0.5 Miles

1 inch = 0.41 miles

N

PREPARED BY: WINTERBROOK PLANNING

DATE PREPARED: April 25, 2013

ABSOLUTE SCALE: 1:38,000

PROJECTION: OR LAMB. CONF. CONIC

DATUM: NAD 83; UNITS: INTL. FEET

Attachment B

Planning-Level Cost Estimates

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

460 Zone Water Main Replacement					
		Buildout			
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Demobilization, Site Prep, and Clean-up (20%)	1	LS	$ 3,000	$ 3,000
2	14-inch Water Main	30	LF	$ 500	$ 15,000
				Rounded Construction Cost Subtotal	$ 18,000
35%	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 7,000
				Rounded Project Cost Subtotal	$ 25,000
15%	Rounded Project Contingency (15%)				$ 4,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 29,000

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

310 Zone Looping (Segments B and C)					
		Buildout			
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Demobilization, Site Prep, and Clean-up (10%)	1	LS	$ 115,000	$ 115,000
2	24-inch Water Main	5,000	LF	$ 230	$ 1,150,000
				Rounded Construction Cost Subtotal	$ 1,265,000
35%	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 443,000
				Rounded Project Cost Subtotal	$ 1,708,000
25%	Project Contingency (25%)				$ 427,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 2,135,000

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

310 Zone Source Facilities (6.8 MGD)					
		Buildout			
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	MOBILIZATION, DEMOBILIZATION, SITE PREP, AND CLEAN-UP (10%)	1	LS	$ 223,850	$ 223,850
2	TEMPORARY EROSION AND SEDIMENTATION CONTROL	1	LS	$ 50,000	$ 50,000
3	24-INCH-DIAMETER WELL DRILLING	300	LF	$ 345	$ 103,500
4	FURNISH AND INSTALL 24-INCH-DIAMETER WELL CASING	300	LF	$ 300	$ 90,000
5	DEVELOP, TEST, AND INSPECT WELL	1	LS	$ 100,000	$ 100,000
6	EARTHWORK	1	LS	$ 20,000	$ 20,000
7	SITE WORK	1	LS	$ 50,000	$ 50,000
8	SITE UTILITIES	1	LS	$ 75,000	$ 75,000
9	WELLHOUSE MECHANICAL	1	LS	$ 750,000	$ 750,000
10	WELLHOUSE STRUCTURAL	1	LS	$ 250,000	$ 250,000
11	WELLHOUSE ELECTRICAL AND AUTOMATIC CONTROL/SCADA	1	LS	$ 750,000	$ 750,000
				Rounded Construction Cost Subtotal (Per Well)	$ 2,463,000
				Rounded Construction Cost Subtotal (3 Wells)	$ 7,389,000
20%	Indirect Costs (20 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 1,478,000
				Rounded Project Cost Subtotal	$ 8,867,000
15%	Project Contingency (15%)				$ 1,331,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 10,198,000

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

310 Zone Conveyance (Segment A)					
				Buildout	
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	Mobilization, Demobilization, Site Prep, and Clean-up (5%)	1	LS	$ 105,800	$ 105,800
2	24-inch Water Main	9,200	LF	$ 230	$ 2,116,000
				Rounded Construction Cost Subtotal	$ 2,222,000
35%	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 778,000
				Rounded Project Cost Subtotal	$ 3,000,000
25%	Project Contingency (25%)				$ 750,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 3,750,000

Webber Street 430 to 310 Zone PRV					
				Buildout	
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	MOBILIZATION, DEMOBILIZATION, SITE PREP, AND CLEAN-UP (15%)	1	LS	$ 12,750	$ 12,750
2	EXCAVATION	1	LS	$ 15,000	$ 15,000
3	VAULT	1	LS	$ 20,000	$ 20,000
4	PIPING AND FITTINGS	1	LS	$ 25,000	$ 25,000
5	12-INCH CLA-VAL PRV	1	LS	$ 25,000	$ 25,000
				Rounded Construction Cost Subtotal	$ 98,000
35%	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 35,000
				Rounded Project Cost Subtotal	$ 133,000
15%	Project Contingency (15%)				$ 20,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 153,000

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

310 Zone Storage Facilities (11 MG)					
		Buildout			
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	MOBILIZATION, DEMOBILIZATION, SITE PREP, AND CLEAN-UP (5%)	1	LS	$ 966,625	$ 966,625
2	11.0 MG GROUND LEVEL STORAGE	11.0	MG	$ 1,750,000	$ 19,250,000
3	SITE WORK	1	LS	$ 82,500	$ 82,500
				Rounded Construction Cost Subtotal	$ 20,300,000
20%	Indirect Costs (20 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 4,060,000
				Rounded Project Cost Subtotal	$ 24,360,000
15%	Project Contingency (15%)				$ 3,654,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 28,014,000

ENGINEER'S PRELIMINARY COST ESTIMATE
RH2 Engineering, Inc.

310 Zone BPS (13 MGD)					
		Buildout			
Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
1	MOBILIZATION, DEMOBILIZATION, SITE PREP, AND CLEAN-UP (10%)	1	LS	$ 410,000	$ 410,000
2	SITE WORK AND UTILITY CONNECTIONS	1	LS	$ 200,000	$ 200,000
3	2,700 GPM BOOSTER PUMP STATION (1) 900 GPM & (2) 1,800 GPM	1	LS	$ 2,500,000	$ 2,500,000
4	1,800 GPM ADDITIONAL PUMPING CAPACITY (DOMESTIC)	2	LS	$ 350,000	$ 700,000
5	1,800 GPM ADDITIONAL PUMPING CAPACITY (FIRE)	2	LS	$ 350,000	$ 700,000
6	EMERGENCY GENERATORS	3	LS	$ 400,000	$ 1,200,000
				Rounded Construction Cost Subtotal	$ 5,710,000
35%	Indirect Costs (35 percent of construction costs and includes construction survey, predesign engineering, design engineering, construction engineering and administration, permitting and inspections)				$ 1,999,000
				Rounded Project Cost Subtotal	$ 7,709,000
15%	Project Contingency (15%)				$ 1,157,000
				Rounded Project Cost Including Construction and Indirect Costs	$ 8,866,000